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PERIOD PREVALENCE OF ACUTE NECK INJURY IN US AIR FORCE
PILOTS EXPOSED TO HIGH G FORCES

Rodger Duane Vanderbeek, M. D.
The University of Texas
Health Science Center at Houston
School of Public Health, 1986

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Neck injury and its sequelae associated with high G forces is an unquantified clinical and epidemiological problem in exposed pilots. There has been a paucity of research in this area. This proposal is a beginning, with a descriptive period prevalence study of acute neck injury in high performance aircraft pilots. A sample of pilots of five different aircraft with varying performance capabilities will be surveyed, utilizing an anonymous questionnaire. Stratified sample data will be analyzed to determine the strength of association of injury prevalence with pilot age, type of G-exposure, and type of aircraft flown.

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USAFSAM/EDK
USAF Aerospace Medical Center
Brooks AFB TX 78235

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PROJECT PROPOSAL

Presented to the Faculty of the University of Texas

Health Science Center at Houston

School of Public Health

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF PUBLIC HEALTH

THE UNIVERSITY OF TEXAS HEALTH SCIENCE CENTER AT HOUSTON
SCHOOL OF PUBLIC HEALTH
Houston, Texas
June 1986

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May 30, 1986

TABLE OF CONTENTS

	Page
Acknowledgments	iii
Abstract	iv
Chapter I: Introduction	1
Chapter II: Problem Statement and Objectives	7
Chapter III: Literature Review	9
Chapter IV: Study Methods and Project Description	12
Chapter V: Discussion	18
Appendices	23
Appendix 1	24
Appendix 2	25
Appendix 3	26
Appendix 4	27
Appendix 5	28
Bibliography	30
Vita	32

CHAPTER I

INTRODUCTION

The performance capabilities of current state of the art Air Force and Navy high-performance 'fighter' aircraft have greatly expanded. These aircraft include the designations F-15, F-16 and F-18; the F-14, F-4, F-5, and A-10 have somewhat lesser performance capabilities. One of the most significant advances has been in the capability to achieve higher positive gravitational forces for longer periods of time and more frequently in all flight environments. This capability exposes the pilot to a significantly more severe occupational stressor than that of previous fighter-type aircraft. Several studies have assessed potential adverse health effects from this high 'G' environment on various organ systems (Burton et al 1985, Hatton et al 1985, Houghton et al 1985, and Whinnery 1979 and 1980). Most of these studies have assessed the effect on the neurologic, cardiovascular and respiratory systems, with particular emphasis on fatigue, performance deterioration, vision effects, loss of consciousness, arterial oxygen saturation, coronary flow effects and cardiac arrhythmias. However, few studies have addressed the short or long term effects of brief high 'G' forces or high sustained G (HSG) on the musculoskeletal system. Frequent pilot reports of neck strain have led to many calls for research, yet little data exist on the possible pathologic effects to the skeletal system of humans from such exposures.

The potential effects of HSG on the musculoskeletal system have been mentioned in the literature, and the need for further studies is frequently mentioned. Yet the actual effects on this system remain anecdotal. Several preexisting subclinical musculoskeletal conditions (mostly spinal conditions) were identified in the 'Proceedings of the USAF Workshop on Pilot Selection and Flying Physical Standards for the 1980s' (Ed. Bonfili, DeHart 1979). These conditions (Appendix 1) were thought to be aggravated by HSG, and various recommendations were made at the workshop for added screening exams to detect these conditions and to revise the physical standards for entry into pilot training for applicants with these musculoskeletal conditions. A subsequent unpublished report (Raddin, 1983) noted the lack of data demonstrating that musculoskeletal problems were increasing in magnitude in the improved aircraft, and a lack of evidence that such subclinical preexisting conditions predisposed to future spinal injury or that those without such conditions were less likely to develop spinal problems.

The gravitational forces exerted on the pilot's body may be applied in any of three axes: 1) the 'fore-aft' or x-axis, denoted G_x ; 2) the 'left-right' or y-axis, denoted G_y ; and the 'head-foot' or z-axis, denoted G_z (Appendix 2). In the high G environment, the x- and y-axes are not significantly stressed; the G_z axis experiences high forces in the positive direction (i.e. from head to seat) up to +9 G's or greater (+1 G is the equivalent of one gravitational force);

the forces in the negative Gz axis are much less, rarely exceeding -2 G's. High G forces are generally considered to be those at or above 6 G's; HSG is defined as greater than 6 G's for 15 seconds or longer. Older combat aircraft were able to achieve HSG for only brief periods, and their excursions into the high G region were often limited by structural design of the aircraft. The advanced fighters, however, are able to sustain high G maneuvers for lengthy periods, and structural integrity of the aircraft is not a consideration until +9 G's or greater are approached. The high G environment is typically experienced during actual combat or during frequent training missions for air combat or advanced aircraft handling maneuvers.

Thus the portion of the musculoskeletal system subjected to the most severe stress is the vertebral column, particularly the neck and to a lesser degree the lower back. The high G forces combined with the frequent turning and tilting of the head and neck increases the potential stresses to the cervical vertebrae. The weight of the protective helmet headgear and of the oxygen mask and accessories add to this stress. Seat back angle has an effect on the dispersal of these high +G forces, with increasing dispersal of +Gz forces into the Gx axis as seat back incline is increased. However, most fighter pilots report that they frequently lean forward, particularly with flexion of the cervical spine, during high G maneuvering to enhance their visual search or to maintain visual contact of an attacker, thus negating the

potential benefit of the increased seat angle to the cervical vertebrae.

There are frequent anecdotal reports of acute neck injury in the fighter pilot community. Some pilots report a much higher frequency of 'neck strain' in the advanced fighter aircraft when compared with the older aircraft they had previously flown. My own personal experience confirms this: as an F-4 pilot for five years I rarely if ever incurred a neck strain secondary to G-forces in flight, yet as a flight surgeon flying in the F-15 and F-16 for one year I had several such incidents. Further, many fellow pilots with several flying hours in both aircraft have personally related to me the significant difference they have experienced between the F-4 and the F-15 or F-16 in the tendency to strain the neck muscles. However, there are no published reports of the actual prevalence of such 'day-to day' neck injuries, nor of their character, quality, duration or sequelae. Neck injury ranges from a mild dull ache to pain and spasm to a debilitating injury with sensory and/or motor deficits. Muscle strain may present as local neck tenderness or may radiate from the occiput to the shoulders or to the area between the scapulae; muscle spasm may also be present. Cervical nerve root injury may present as a dull ache or pain in the neck or shoulder or arm, or may be described as a numbness or tingling in the distribution of the nerve, extending distally to the hands and fingers. In

more severe cases reflexes may be diminished and there may be impairment of motor function of the affected upper extremity.

Many pilots do not seek medical attention for such injury unless they are incapacitated or are truly unable to continue to fly. Thus many such cases are never reported to the medical community. There are only a very few actual documented cases of cervical spine injury with either vertebral fractures, herniated nucleus pulposus, or ligamentous tear secondary to high G exposure. (Many studies and cases exist for impact or ejection injuries.) The advanced aircraft have now been in operation from three to nine years, with some pilots now exceeding the 1000-hours total flying milestone in the F-16. No studies have assessed data on disability retirement or separations in these pilots, but such data are not yet interpretable due to the still relatively brief years of exposure to these aircraft for the very large majority of pilots.

Thus neck injury and its sequelae are unquantified clinical and epidemiological problems in pilots exposed to high G forces. The purpose of this proposal is to describe the period prevalence of acute neck injury in this community of high-performance jet 'fighter' pilots, through the use of a sample survey questionnaire. Types of injuries are described and classified. Comparisons will be made between the prevalence by type aircraft, pilot age, and type of high G exposure.

Once this study is completed, if the magnitude or the severity of the problem is thought to be significant, then long term cohort studies should be carried out to assess any chronic ill effects from repeated exposures to high G. Is there a degenerative effect to the cervical spine, even in the absence of fracture, disk herniation or ligamentous tear? Are we at the edge of human tolerance with these G exposures or is there more 'G-room' in which to expand without risk of long-term injury? A new occupational arena has been entered; assessment of potential deleterious long term effects on these pilots is imperative. If exposure to high G leads to chronic ill health effects, then measures need to be implemented to reduce exposure or to enhance protective methods. Such data would also be useful to support or to deny future claims of G-related occupational disability. In the interim, pilots of such aircraft may be wise to increase their neck and lower back muscle strength, and to minimize their G-exposure in their daily flying (by decreasing the frequency, duration and quantity of their exposure). Further research and design efforts should be directed at reduction of G-exposure or G-effects through improved anti-G garments and pressure valves, and increased seat angle design to direct more aircraft Gz into the pilot's Gx axis.

CHAPTER II

PROBLEM STATEMENT AND OBJECTIVES

The specific problem to be investigated by this study is the determination of the prevalence of acute cervical injury due to high G forces in US Air Force pilots. This objective will be accomplished through a survey questionnaire given to a sample of pilots of various types of aircraft in the United States Air Force.

A further objective will be to compare the stratified data from the sample to determine if prevalence of neck injury is associated with pilot age, type of aircraft, or type of G exposures.

Importance

Collection of data on this potential risk of occupational injury is lacking in the literature. There is not only a risk of acute injury to the cervical spine, but also an unqualified and unquantified risk of long-term injury or degenerative effects. Such data are important in assessing occupational risk, in determining the validity of possible future G-disability claims, and to direct research needs in improved 'G-protection' for exposed pilots.

There are also implications for future cockpit designs of even more advanced combat fighter aircraft, and on the performance spectrum designed into these aircraft. Can man tolerate the potential 10+ Gz capabilities of these advanced aircraft? What is the operational tolerance of the human cervical spine?

These questions, and no doubt many others, need answers. This descriptive study may be the first step towards the answer to some of these questions.

CHAPTER III

LITERATURE REVIEW

Literature on the effects of high G on the vertebral column is still largely in the anecdotal stage of reporting. There still have been no long term human studies on these effects, and no prevalence or incidence studies on neck injury. A few studies warrant mention:

Delahaye and Auffret (1980) raised the question of a potential for development of arthritides from the repeated 'micro-trauma' of flight. One human study to +13.5 Gz was described, with resultant cervical injury and rapid development of post-traumatic cervical arthritis at C5/6/7. Various 1958-1976 European studies are described that conflict on whether flying high performance aircraft contributes to the development of cervical arthritis. The few known aggravations of pre-existing spinal disorders followed only severe trauma.

Primate studies have shown conflicting results in the effects of high G on the vertebral column. Slonim et al (1981) showed a possible decreasing strength in baboon vertebral strength after frequent high G stress.

McNish (1982) showed no difference in G-related diagnoses in the USAF aeromedical waiver file for fighter-attack pilots versus tanker-bomber-transport pilots; however, at the time of this study there were only a very small number of pilots with any significant exposure to high G in the F-15 and F-16 aircraft and none in the F-18. McNish is continuing

to compile G-exposure profiles per 100 flying hours for the various high performance aircraft.

Vandenbosch (1984) discussed the Belgian experience in which full anterior-posterior spine X rays of the thoracolumbar spine and cervical spine X rays were added to their screening exams for F-16 pilots. He reported a high frequency of complaints of cervical ache; clinical impression was that subsequent neck muscle training has decreased these complaints. One case of a subluxation of a cervical vertebrae is mentioned but is not discussed.

Gillingham et al (1985) described the G-exposures, loading, and onset rates for four high performance aircraft (F-4, F-5, F-15, and F-16). The F15 and F16 were found to have significantly more exposure in all 5 of the measured parameters; the F16 was found to have a significantly higher exposure in two parameters--time at and time over +7G's.

A personal conversation with Dr. David G. Schall, Chief of Aeromedical Services at Luke Air Force Base, Arizona, and focal point for all G-related neck injuries in Tactical Air Command, revealed a pending report on at least six cervical spine non-impact injuries in F-15 and F-16 pilots due to high G exposure (all are either fractures, HNP's or ligamentous tears).

This review illustrates the significant gaps that exist in our knowledge about the acute or long-term effects of high G exposure in advanced aircraft. Much more research

is needed. This proposed prevalence study is only a starting point.

CHAPTER IV

STUDY METHODS AND PROJECT DESCRIPTION

This proposal is for a period prevalence observational descriptive study of acute cervical syndromes in US Air Force pilots. It is a community oriented population survey. Data will be collected through an anonymous survey questionnaire (Appendix 3). The specific data collected will include the number and type of neck injury by period, the pilot's age, his flying experience by type of aircraft, and for the four fighter aircraft the type of flying currently involved in (operational or training). History of any prior traumatic vertebral injury is also identified.

Neck injury is the dependent variable of main concern, and this will be quantified as the numerator by the number of pilots with at least one acute cervical injury in the period specified (one or three months). The denominator will be the population at risk, i.e. all G-exposed pilots, for each of the sample strata. Those with a prior history of traumatic or sports neck injury will be excluded from the study.

Neck injury may be classified into several types. Certain serious injuries can be documented by various radiological methods. These lesions include fractures of the vertebral body or arch, herniated nucleus pulposus ('ruptured disk) and ligamentous tears.

Milder injuries cannot always be demonstrated by diagnostic methods and are referred to as acute cervical syndromes. These are defined as any of several entities caused by irritation or compression of the cervical nerve roots. Several types of syndromes are recognized:

Cervical neck muscle pain or tenderness, with or without radiation into the back or shoulders.

Cervical neck muscle spasm.

Torticollis represents a more severe strain with contraction of the cervical muscles producing a twisting of the neck and a resultant unnatural head position.

Sensory deficits in the distribution of the affected nerve root. Paresthesias refer to the symptoms of burning, numbness, tingling or prickling. Dysesthesia refers to any sensory impairment, but especially that of touch.

Motor deficits: decreased deep tendon reflexes or frank impairments of coordination, dexterity or movement.

This study will not include individuals with vertebral fractures, ligamentous tears or herniated disks. Only those with acute cervical syndromes, as defined, will be included in the study. The data will also allow quantification of the number of cases in each period, as some pilots will have more than one injury in the period. This may warrant further study into the types of pilots who seem more

susceptible to recurrent injury than others, however it will not be addressed in this study.

The phases of this study and associated time table are included as Appendix 4 herein. The entire study is programmed over a nine month period. Budgetary considerations and an outline of same are detailed on Appendix 5.

Data from completed questionnaires will be entered into and analyzed using a mini-computer resource with appropriate statistical software. Completed questionnaires will be maintained in a locked cabinet until completion of the study, then they will be destroyed.

Statistical Analysis

The period prevalence ratio is determined by dividing the number of current cases in the period by the number at risk for each type of aircraft (Friedman, 1980). A current case is defined as a pilot who had at least one neck injury secondary to high G exposure in the period. Data for pilots with greater than one injury in the period will be recorded, but not analyzed in this study. Populations to be sampled and compared include pilots from: 1) both an operational flying base and a training base for each of four aircraft--the F-16, F-15, F-5, and F-4; and 2) a cargo/transport aircraft base as a group of non-exposed pilots. Anonymity and confidentiality will be highly stressed. The expected number of pilots available to be surveyed at each base ranges from 50-80 pilots for each type of aircraft, and all pilots at each base will be surveyed.

Bases to be surveyed tentatively include the following:

Two bases with F-16 aircraft--one operational,
one training.

Two bases with F-15 aircraft--one operational,
one training.

Two bases with F-4 aircraft--one operational,
one training.

Two bases with F-5 aircraft--one operational,
one training.

One base with tanker and cargo aircraft.

The period prevalence of neck injury for all groups exposed will be determined, then comparisons will be made between various sample strata. Strata will include groupings by type aircraft, pilot age, and by type of flying for the fighter aircraft (operational versus training environment).

Statistical analysis will consist first of showing the strength of various associations using 2xC tables, then testing for statistical significance for each table using the Chi-square test with (C-1) degrees of freedom (Kleinbaum, 1982). Significance level will be set at p-value less than .05. Causality cannot be inferred from associations, and will not be implied.

The dependent variable in all tables is the presence or absence of neck injury. One sample statistic is the period prevalence for the entire sample surveyed, without

stratification. The effect of age will be assessed by grouping the sample into five year age blocks with all pilots under 25 or over 40 lumped (age blocks: 24 or less; 25-29; 30-34; 35-39; 40 or over). Most active pilots in the Air Force are between ages 25 and 45. These tables will be further stratified by type of aircraft, generating five 2xC tables for each aircraft showing prevalence for each age block.

To assess the association of type aircraft with prevalence, the columns of one 2xC table will consist of the five aircraft surveyed, ordered from expected least to most G capability (Gillingham et al, 1985). Thus column 1 will be the tanker-cargo pilots and column 5 will be the F-16. Actual G-exposure is very difficult to quantify, and McNish's work should help clarify these parameters. Until then, increasing aircraft performance capability is considered to correlate to increasing G-capability and thus to potential G-exposure. This 'prevalence by type aircraft' table will be further stratified into the age blocks, generating five 2xC tables for each age strata showing prevalence by type of aircraft flown. An extended Mantel-Haenszel method will be used to analyze the strength of association between the several 2xC tables (Kleinbaum, 1982).

For type of G-exposure, a 2x2 table will be generated with the two columns labeled 'operational' and 'training', for the two types of flight environments for the four fighter

aircraft only. This table could be also stratified into several 2x2 tables by additionally stratifying on age.

It is expected that some stratified groups will have zero or very low prevalences. Attempts will not be made to show associations by the Mantel-Haenszel method unless all of the expected cell frequencies are larger than 1, and most are at least 5.

CHAPTER V

DISCUSSION

Several factors are to be considered in the design and execution of this study and in the interpretation of data. Several of these factors are discussed in this chapter.

Proposal Limitations and Biases

Anonymity is critical to the validity of this study. Many pilots are reluctant to reveal almost any medical problem for fear of reprisal or discovery and subsequent effects on their flying careers. They often think of their flight surgeon as an adversary who can only harm their careers. The pilots thus must be assured of anonymity and that no medical or administrative action can be taken against any participant in the survey. This is essential in order to have valid and full completion of the survey questionnaire.

Questionnaire completion also is affected by its complexity and clarity. An effort has been made to keep the questionnaire as simple and straight-forward as possible. Formulation of the questionnaire will be finalized with the assistance and inputs of several current pilots at Luke Air Force Base, Arizona, who have offered this assistance. A draft of the questionnaire will be administered to a small group of pilots at Luke Air Force Base to assess its clarity.

Other selection biases include non-response and information bias (Kleinbaum, 1982 and Sackett, 1979). The survey itself will be accomplished by pre-arranged visits to

each air base to be sampled. I will personally introduce, administer and collect the questionnaire. These efforts combined with anonymity should limit non-responses or false questionnaire completion. Assertions to the pilots of the potential benefit of the study should increase compliance and validity.

The selection of bases to be surveyed is not critical and is thus considered unbiased. For any particular type of aircraft there are several bases in the United States and overseas that are involved with flying of that type of aircraft. With the exception of a training base versus an 'operational flying' base, the type of flying at each base with similar aircraft is considered to be identical for this study. Thus any base surveyed with F-16 aircraft, e.g., is considered representative of all bases with F-16's.

Sex is not a consideration since all pilots surveyed will be male. Race will not be examined, as 98-99% of all pilots to be surveyed are white. All pilots entering into Air Force pilot training meet the same physical examination and screening standards, and selection for type of aircraft is not dependent on physical criteria. Selection is based on academic and flying skills performance in pilot training, and these are not considered to be biases that might affect future potential for acute cervical injuries.

Headgear similarly is not considered to be a factor, as all pilots now wear very similar helmets and oxygen mask equipment, with very similar weights.

G exposure is a quantity that must be considered in assessing occupational risk. The different types of aircraft have differing capabilities to achieve and sustain various +Gz levels. Duration and frequency of exposure to the various G levels differs among the aircraft and with the type of flying encountered. The operational flying environment typically involves more high G missions than does the training environment. Experienced pilots are said to use less G in their maneuvers than pilots with fewer hours of air combat training. Gillingham et al (1985) has provided one analysis comparing the G-environment of four fighter type aircraft. His study demonstrates that the F-16 tends to expose the pilot to G forces more frequently and to a higher degree than the F-15, and the F-15 more so than the F-4. The tanker and cargo aircraft are never exposed to G forces exceeding +3 Gz, and only very rarely over +2 Gz. McNish (1983) is currently analyzing G exposure data for several aircraft types, in an attempt to develop a model for assessing overall annual or lifetime G exposure for pilots of these various aircraft. These factors will be addressed in the discussion and conclusions after completion of the proposed study.

Recall bias should be minimized due to the type of data requested on the questionnaire and due to the short recall intervals addressed. A pilot may have difficulty recalling the exact number of acute injuries over a specified

time period, but the relevant finding is any neck injury in the period studied.

Confounding variables already mentioned include age, type of aircraft flown, and type of flying environment (operational versus training). Additional variables include pilot experience, pilot duty status (instructor, student, or squadron pilot), and actual G exposure levels. Some of these will be discussed in the final report after study completion, but statistical analyses will not be performed on these additional confounders.

Expected Results and Summary

The main objective of this study is to determine the prevalence of acute cervical injury in pilots exposed to high G forces. This author believes that the prevalence exceeds 20% in any one month period in the state-of-the-art advanced fighter aircraft, and may approach 50% prevalence in some sub-groups. Prevalence of neck injury is thus expected to be higher in the newer fighter aircraft than that in lower performance aircraft that experience less, if any, high G exposures. Thus it is expected that prevalence will be greater in the F-16 and F-15 pilots than in F-4 or F-5 pilots, and nearly zero in cargo or tanker aircraft pilots. If this is not observed in the sample, then it suggests that the difference in G-exposures is not significant with respect to association with neck injury, and it would suggest no increased risk of such injury in the new advanced aircraft.

If high G has a cumulative effect then a trend of increasing prevalence with increasing G-capability by type of aircraft is expected. If age increases susceptibility to injury, then a trend of increasing prevalence with age is expected. The absence of such a trend would suggest that cumulative effects or age-susceptibility are not associated with prevalence of neck injury due to high G exposure.

If operational flying environments expose the pilot to high G forces more frequently or to higher peak G-levels than does the training flying environment, then a greater prevalence is expected in operational pilots versus trainer pilots in each type of aircraft. If there is no difference then it suggests that the two environments are similar with respect to G exposure.

But what prevalence is to be considered significant? Certainly a prevalence such as 40-50% in high G-exposed pilots would be significant, but what of 5-10%? Prevalence significance will be explored and expanded after the study is completed. The long-term questions to be addressed are these: 1) For those pilots exposed and having acute injuries, what are the acute and chronic effects on the cervical spine? 2) Are repeated exposures cumulative? 3) Are there degenerative effects such as cervical arthritis? 4) Can the cervical spine tolerate even more high G without deleterious effects? Needed long-term prospective studies will address these questions. This proposal will qualify and quantify the presence of the potential injurious exposure.

APPENDICES

Appendix 1

Musculoskeletal Conditions Thought to be
Aggravated by High Sustained G

-
1. Cervical Degenerative Joint Disease
 2. Lumbosacral Degenerative Joint Disease
 3. Spondylitis
 4. Spondylolysis
 5. Spondylolisthesis
 6. Scheuermann's Disease (Kyphosis)
 7. Prominent Lordosis or Kyphosis
 8. Klippel-Feil Anomaly (Congenital Short Neck)
 9. Sprengel's Anomaly (Congenital High Scapula)
 10. Ankylosis
 11. Schmorl's Nodes
 12. Hypertrophic Transverse Process L-5 (Articulating with the Ileum)
 13. Hemivertebra
 14. Spina Bifida
 15. Spinal Canal Stenosis
 16. L-5 Sacralization
 17. Lumbarization of First Sacral Vertebrae
 18. Radiological Evidence of Basal Impression
 19. Cervical Ribs
 20. Scoliosis
 21. Intraspongy Nuclear Herniation
 22. Significant Compression or Loss of Height of Any Vertebral Body
-

Source: Proceedings of the USAF Multidisciplinary Workshop.,
Ed. Bonfilli HF, DeHart RM. 3-5 April 1979, p20.

Appendix 2

Comparative Table of Equivalents Used
in Acceleration Physiology

Linear Motion	Inertial Resultant of Body Acceleration	
	Physiologic Descriptive (1,2)	Physiologic Computer Std. (3)
Forward	Transverse A-P G Supine G Chest to Back G	+Gx
Backward	Transverse P-A G Prone G Back to Chest G	-Gx
Upward	Positive G	+Gz
Downward	Negative G	-Gz
To Right	Left Lateral G	+Gy
To Left	Right Lateral G	-Gy

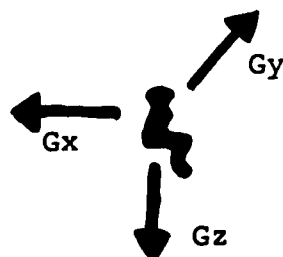
Footnotes:

- 1) Large letter, G, used as unit to express inertial resultant to whole body acceleration in multiples of the magnitude of the acceleration of gravity.

Acceleration of gravity, g_0 , =

980.665 cm/sec² or 32.1739 ft/sec².

- 2) A-P, P-A refers to Anterior-Posterior, Posterior-Anterior
3) Positive direction of G force is indicated by vector in each axis:



Source: Developed after Gell (1961) and McNish (1983).

Appendix 3

SURVEY QUESTIONNAIRE

Form _____

Neck injury may be an occupational risk for hi-performance fighter pilots. This survey is intended to determine the magnitude of this problem in the fighter community. THE SURVEY IS ANONYMOUS! Full participation and completion are important to make the study valid and informative. Please answer all questions to the best of your recollection.

Age _____ Rank _____ Status (circle): IP / A/C / Student

		<u>Type Acft</u>	<u>Years Flown</u>	<u>Hours this Acft</u>
Flying	Present	_____	_____	_____
History				
	Previous	_____	_____	_____
		_____	_____	_____

Type flying now: Operational/RTU Total Hours _____
 Estimate sorties per month of ACM/BFM: _____

Have you ever injured or fractured your neck from an accident or from sports trauma or from prior ejection? Yes / No

Type Injury _____ Year Injured _____

Are you on any medical waiver for flying duties for any pre-existing or acquired back or neck problem or injury? Yes / No

Indicate # of injuries per period on the appropriate line:

<u>Type of Neck Injury</u>	<u>Past Month</u>	<u>Past 3 mos.</u>	<u>Past Year</u>
Dull ache neck/shoulders	_____	_____	_____
Muscle spasms	_____	_____	_____
Pain in neck or shoulders	_____	_____	_____
Pain radiating into arm(s)	_____	_____	_____
Numb/tingly or prickly in hands or fingers	_____	_____	_____
Decreased dexterity or movement skills of arm or hands or fingers	_____	_____	_____
Any other: (describe)	_____	_____	_____

If you flew older fighters previously, did you experience similar neck injuries? Yes / No. If yes, were they more/less/same frequency; more/less/same severity (circle one option each).

Comments: (use reverse if needed)

Appendix 4

Study Phases

2 Months: Selection of bases to survey, pre-coordination for visit. Biostatistician consulted.

3 Months: Sample survey data collected by personal visits to each selected base; questionnaire distributed, completed and collected.

3 Months: Data collation, interpretation and analysis.

1 Month: Preparation of final report of the study: Typing, copying and slide production for presentation.

Appendix 5

BUDGET

- I. Office space containing:
 - 1. Desk with chair
 - 2. Telephone with long distance (military and commercial) access
 - 3. Filing cabinet(s)
 - 4. Lighting
- II. Equipment:
 - 1. Typewriter
 - 2. Stationery and general office supplies
 - 3. Dictation equipment
 - 4. Photocopy machine access
- III. Personnel:
 - 1. Principal investigator
 - 2. Typist/secretarial assistant
 - 3. Biostatistician--for consultations prior to start of study, and after collection of all data
- IV. Postage:
 - 1. Government routes when possible
 - 2. Expenses for express mail or when government mail system unable to support
- V. Travel:
 - 1. Principal investigator travel and lodging at each base surveyed

2. Rental auto at each base visited
3. Reimburse travel for consultants to and from office

VI. Presentation:

1. Offprints
2. Audiovisual equipment:
 - a) Overhead projector
 - b) Slide projector and screen

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VITA

Rodger Duane Vanderbeek [REDACTED], [REDACTED]
[REDACTED] [REDACTED]
[REDACTED] he grew up on a farm near Oskaloosa.


After graduation in 1967 from North Mahaska High School, New Sharon, Iowa he attended the University of Iowa, Iowa City, Iowa and graduated in 1971 with a Bachelor of Science degree in General Science.

He was commissioned as a 2nd Lieutenant in the United States Air Force and entered undergraduate pilot training at Williams Air Force Base, Arizona, completing this training as a distinguished graduate in 1972. He then entered advanced training in the F-4 aircraft at MacDill Air Force Base, Florida. After completion of this training in March 1973 he was assigned to Kunsan Air Base, Republic of South Korea for one year followed by three years at Holloman Air Force Base, New Mexico.

He separated from active military service in August 1977 and returned to the University of Iowa for graduate studies in science education. In August 1978 he began medical school training at the College of Medicine at the University of Iowa, and received the degree of M.D. in May 1982. He completed a one year flexible internship at Good Samaritan

Medical Center, Phoenix, Arizona in June 1983, then re-entered active military service in July 1983 as a flight surgeon at Luke Air Force Base, Arizona. In September 1984 he transferred to Homestead Air Force Base, Florida and served one year as the Chief of Aeromedical Services at the base hospital, receiving the Meritorious Service Medal for his work there.

He currently is studying towards a Masters in Public Health degree at the University of Texas Health Science Center at San Antonio, and expects to complete the second year of this residency in aerospace medicine at Brooks Air Force Base, Texas in July 1987.

Permanent address: 

This proposal was typed by Paula L. Stegeman.